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PROTECTIVE FINISHES FOR CANNON TUBE BORE EVACUATOR SURFACES

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13. ABSTRACT *(Maximum 200 words)*

This report presents a series of protective finishes that were evaluated for production use on the M68 cannon tube. The purpose of these protective finishes is to prevent corrosion on the tube surface beneath the bore evacuator, which is subjected to relatively high temperatures. Following the initial evaluation phase, finishes that would adversely affect producibility were eliminated and select finishes were subjected to salt spray testing to determine relative resistance to corrosion.

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STATEMENT OF THE PROBLEM

The 105-mm M68 and M68A1 have been in production for more than twenty-five years. During this time the tube surface under the bore evacuator has had a bare metal finish. Information received from Anniston and Mainz Army Depots regarding M68 cannon tubes returned from the field during vehicle rebuild programs indicated that many tubes were being scrapped due to corrosion and pitting beyond allowable limits.

Current criteria specified in Technical Manual 9-1000-202-14, "Evaluation of Cannon Tubes," require condemnation if pits in the tube surface underneath the bore evacuator exceed 0.125 inch in depth.

In an effort to reduce the number of tubes condemned due to corrosion in this area, a number of coatings were evaluated. This report contains the results of this investigation and testing.

BACKGROUND

The finish coating specified for the outside surface has changed very little since initial production of the 105-mm M68 tube. A paint finish for the finish-machined tube is specified on Drawing F8765961 for the M68 and Drawing F11579696 for the M68A1. The finish is applied as follows:

- Wash Primer - per DOD-P-15328
- Primer - per TT-E-485 or MIL-P-52995
- Final Coat - per MIL-E-52798 or MIL-E-52929

The tube is painted only on nonbearing surfaces; the recoil slide surface and area under the bore evacuator are not painted. During firing of the cannon, the unprotected area under the bore evacuator is subjected to hot propellant gases and begins corroding. Although maintenance procedures specified in Lubrication Order LO 9-2350-215-12 require removal of the bore evacuator, cleaning, and application of the cleaner, lubricant, and preservative to the tube surface per Specification MIL-C-63460, corrosion still occurs.

APPROACH TO THE PROBLEM

A description of the different protective coatings evaluated follows:

Protective Coatings

Boron Nitride - Boron nitride is a product of Union Carbide claiming excellent corrosion resistance up to 3000°F. This material was discovered to be unsuitable because of a requirement for a 200°F bake for 4 hours, which would increase the unit cost of the M68/M68A1 cannon tube appreciably. The process would also be new to Watervliet Arsenal with associated specialized equipment costs.

Teflon™ - The corrosion resistance and heat resistance of Teflon™ coatings are well-known even outside of engineering circles. This material conforms to Society of Automotive Engineers' Aerospace Materials Specifications AMS 2515 and AMS 2516. It was rejected due to a requirement for a very high temperature bake (800°+F) which would lead to a considerable increase in unit cost, as well as increased production time and addition of a new process.

Ion Vapor Deposited Aluminum (IVD) - This is a proprietary process of McDonnell Douglas Corporation. The nearest authorized/licensed Ivadizer™ shop is in Connecticut, and expensive special arrangements could be necessary for this process to be brought into Watervliet Arsenal. The alternative would be to ship cannon tubes outside the arsenal for preparation. Numerous reports exist showing the superiority of IVD aluminum coating compared to cadmium plating in corrosion testing. Data also exist showing IVDs superiority in areas where galvanic corrosion may occur such as titanium and aluminum structures.

Heat Resisting Aluminum Paint - Heat resisting aluminum paint conforms to Federal Specification TT-P-28, and is billed as being resistant to solvents, weathering, and temperatures as high at 1200°F. It is primarily for use in furnaces and other very high temperature applications. This material was selected for testing (see Figures 1a and 1b).

Primer Pretreatment - Primer pretreatment conforms to Military Specification DOD-P-15328. This coating is the initial step in the paint system specified in General Data Drawing A7309997. It is mainly used as a wash primer to prepare surfaces for subsequent paint applications. This material, although not initially selected, was provided by the Preservation and Packaging Branch of Watervliet Arsenal for testing (see Figures 2a and 2b).

Zinc Chromate - Zinc chromate is a standard primer used principally in the aerospace industry for structural interiors. This material, although not initially selected, was also provided by the Preservation and Packaging Branch for testing (see Figure 3).

Primer - Primer conforms to Federal Specification TT-E-485 and is listed on the previously mentioned general data drawing as a second step following wash primer pretreatment. This material is also used by the Anniston Army Depot as a protective surface coating in the area of the bore evacuator of the M68/M68A1 cannon tubes during vehicle rebuilding. Primer was selected for testing, as shown in Figures 4a and 4b.

Solid Film Lubricant - In accordance with General Data Drawing B8769470 and Military Specifications MIL-L-46010 and MIL-L-23398, this material is not used on the M68/M68A1 cannon tubes, although it does have application on 155-mm cannon tubes. Though a high temperature bake of 450°F is required, the process is not new to Watervliet Arsenal and could easily be incorporated in the M68/M68A1 technical data package. This material was selected for testing as shown in Figures 5a and 5b.

Chemical Agent Resistant Coating - In September 1985, General Data Drawing B11579832 was released describing the requirements for chemical agent resistant coating (CARC). CARC is mandatory for inclusion in technical data packages throughout the Army. It is important to nuclear, biological, and chemical warfare because is resists impregnation by chemical agents or other contaminants that are easily rinsed off. This material was selected because of its reportedly good chemical and heat resistance. It is specified for application on exterior surfaces in accordance with Specifications MIL-P-52192, MIL-P-53030, and MIL-C-53039 (see Figures 6a and 6b).

Test Procedure

The test procedure involved applying the selected coatings to standard 3-inch by 6-inch test coupons and subjecting the coupons to salt spray for 48 hours in accordance with ASTM B-117. Although the test does not exactly duplicate the service conditions, it gives a good indication of the performance of the coatings under standardized corrosion testing conditions. It is believed that the results of this comparative experiment are relevant.

RESULTS

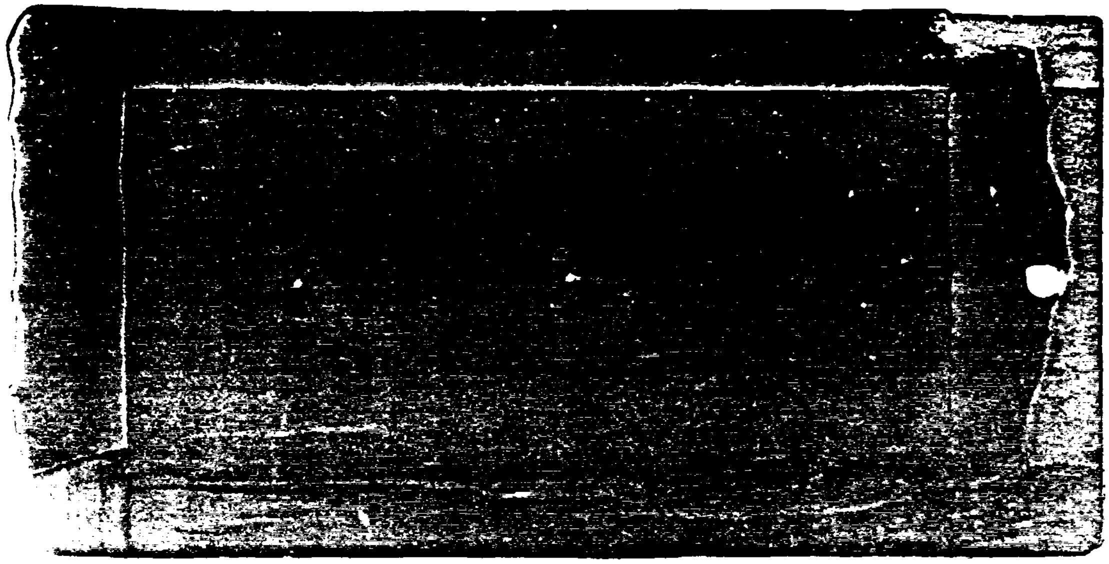
After the specimens completed the 48-hour exposure to salt spray, the test coupons were evaluated by the degree of corrosion present. Specimens that evidenced only a few spots of rust were judged marginally acceptable, while specimens that showed areas of complete penetration were judged failures. Those coupons exhibiting no penetration or staining whatever were judged completely successful. The accompanying figures show the relative appearance of the test coupons.

Marginally acceptable performance was not evident in any specimens tested with large areas of corrosion present in the majority of test panels. Especially noteworthy is the complete failure of the primer materials (Figures 2a, 2b, 3, 4a, and 4b) which confirms many people's personal experiences with automotive primer: primer by itself is not a good coating for corrosion resistance because of its high porosity. Paint by itself performs inadequately as shown in Figures 1a and 1b; however, the silver heat resisting paint's corrosion performance might have benefited slightly from a primer undercoat, but suffers itself from porosity sufficient to cause corrosion of the base metal.

The application of a topcoat to a properly primed substrate is vital to the integrity of any paint system, as evidenced by the successful performance of the CARC paint system shown in Figures 6a and 6b. The application of solid film lubricant can be an effective deterrent to corrosion when the solid film lubricant is baked. The only improvement to the solid film lubricant system is a substrate of manganese or zinc phosphate. Air-drying solid film lubricant is only useful as temporary protection against corrosion and should be accompanied by an application of preservative oil or grease.

CONCLUSIONS

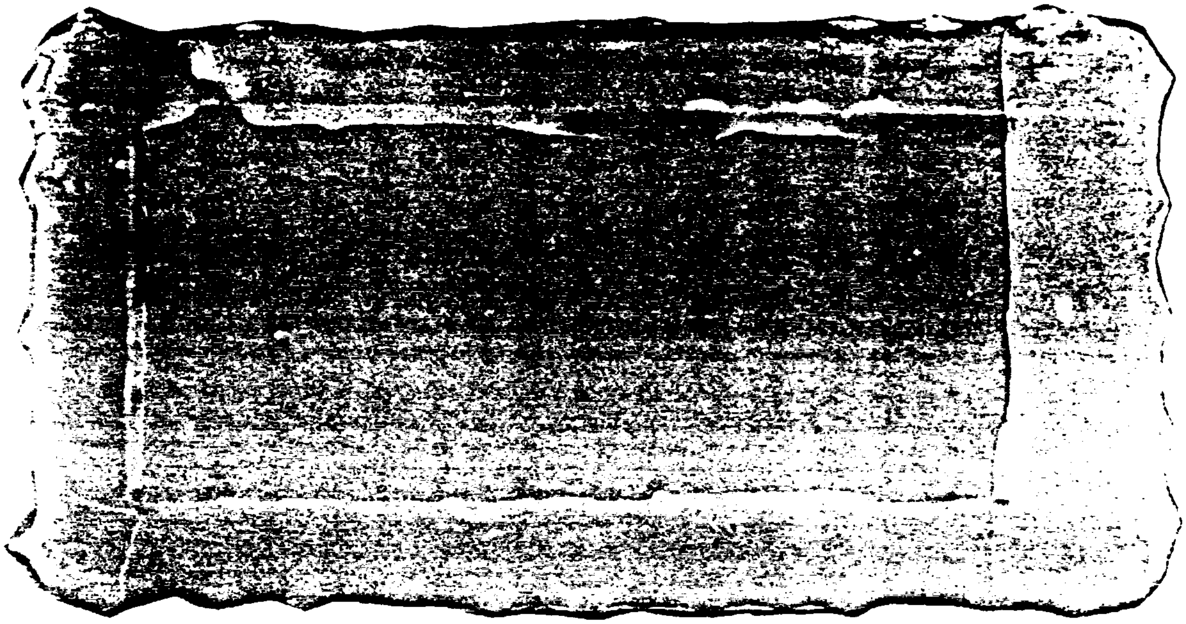
The obvious candidates for a corrosion-resistant coating for the cannon tube surface underneath the chamber evacuator assembly are baked solid film lubricant and chemical agent resistant coating. The selection is a matter of economics for the M68/M68A1, since the solid film lubricant would mean an additional process for the cannon tube above and beyond currently specified protective-finish requirements. The desirable alternative is the application of CARC, which has been specified for use on the cannon tube surface beneath the chamber evacuator assembly of the M68/M68Al and also for use on the surface underneath the bore evacuator of the M256.



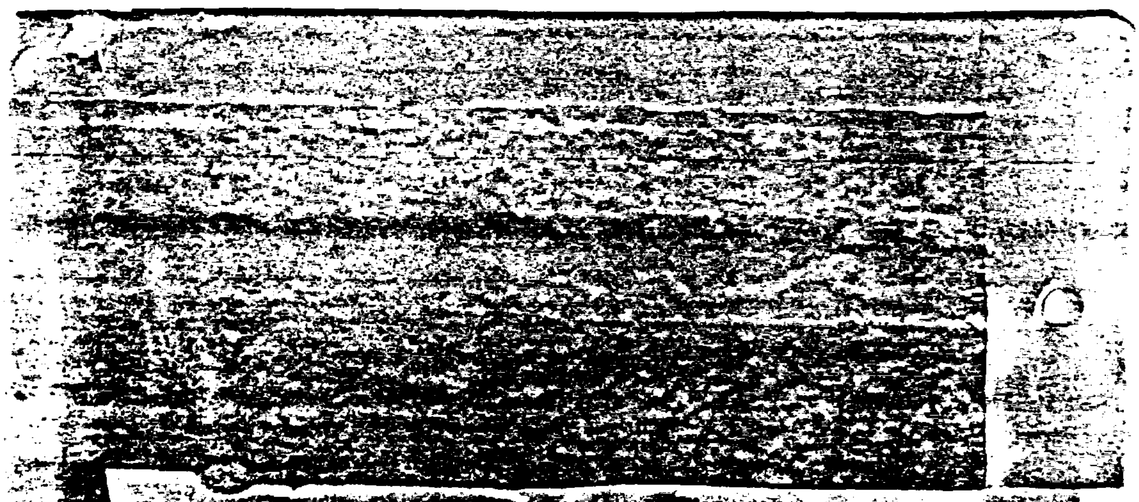
(a)

(b)

Figure 1. Aluminized paint per Federal Specification TT-P-28 (failed).



(a)



(b)

Figure 2. Wash primer per Military Specification DOD-P-15328 (failed).

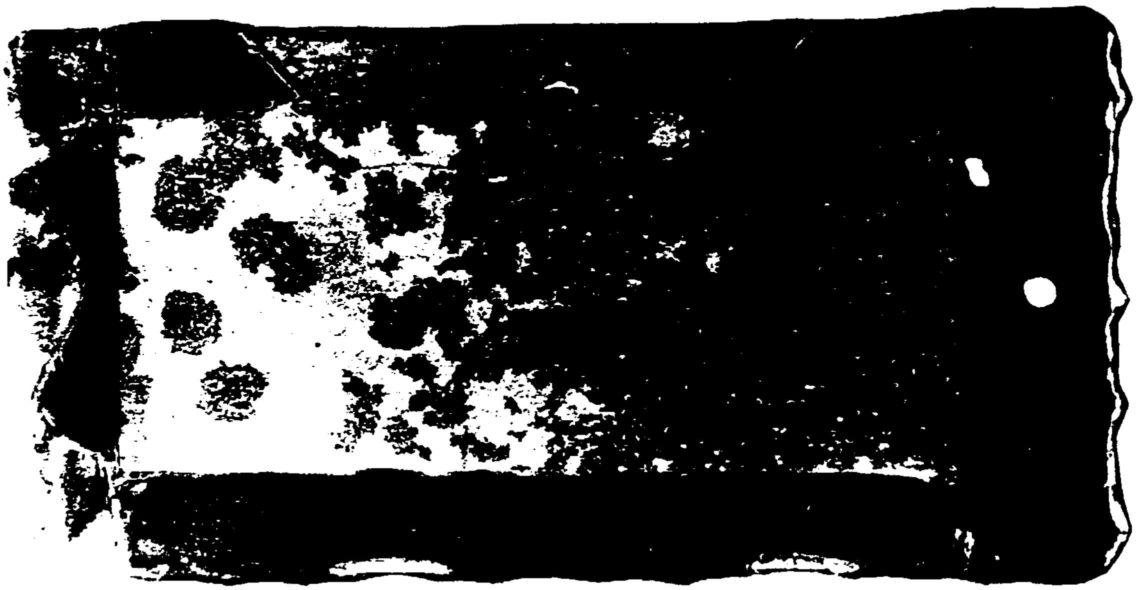
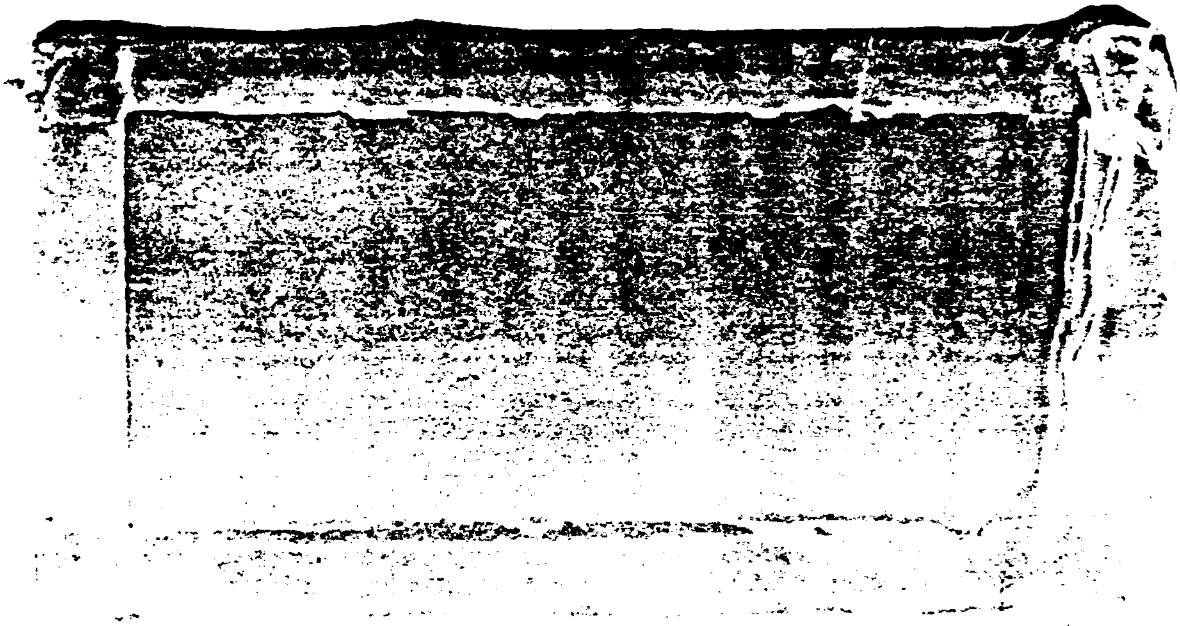
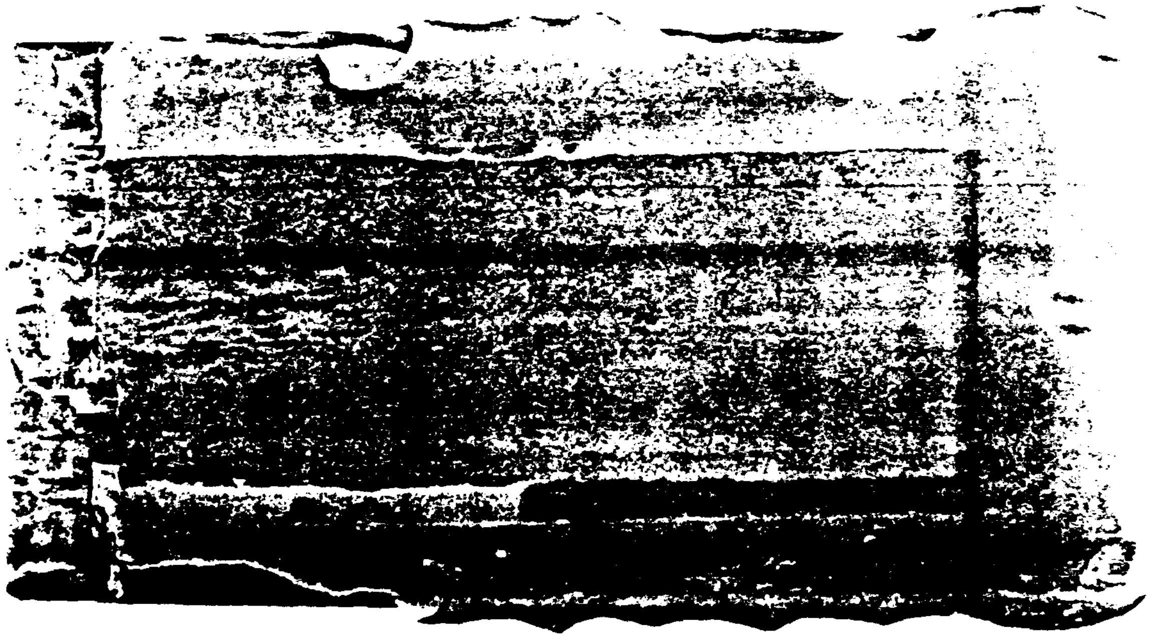


Figure 3. Zinc chromate primer (failed).

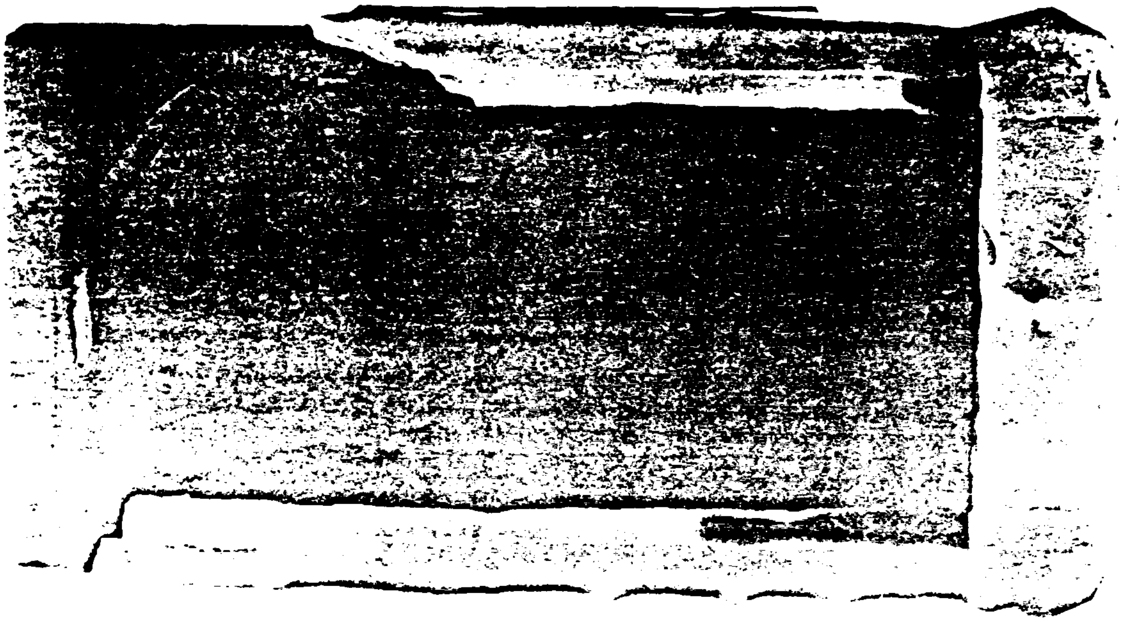


(a)

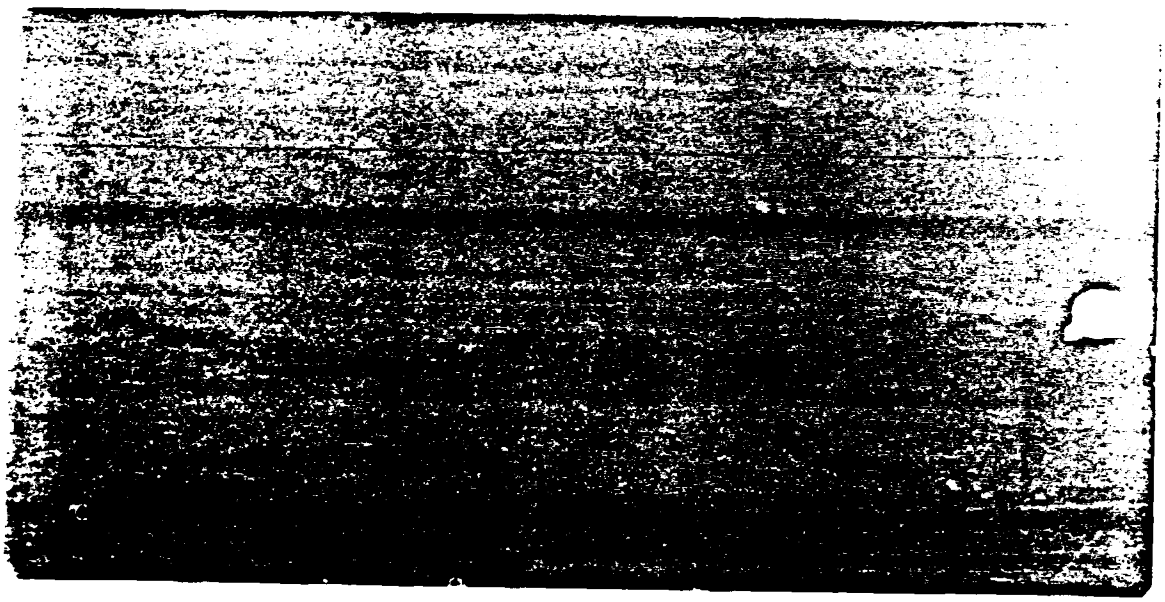


(b)

Figure 4. Primer per Federal Specification TT-E-485 (failed).

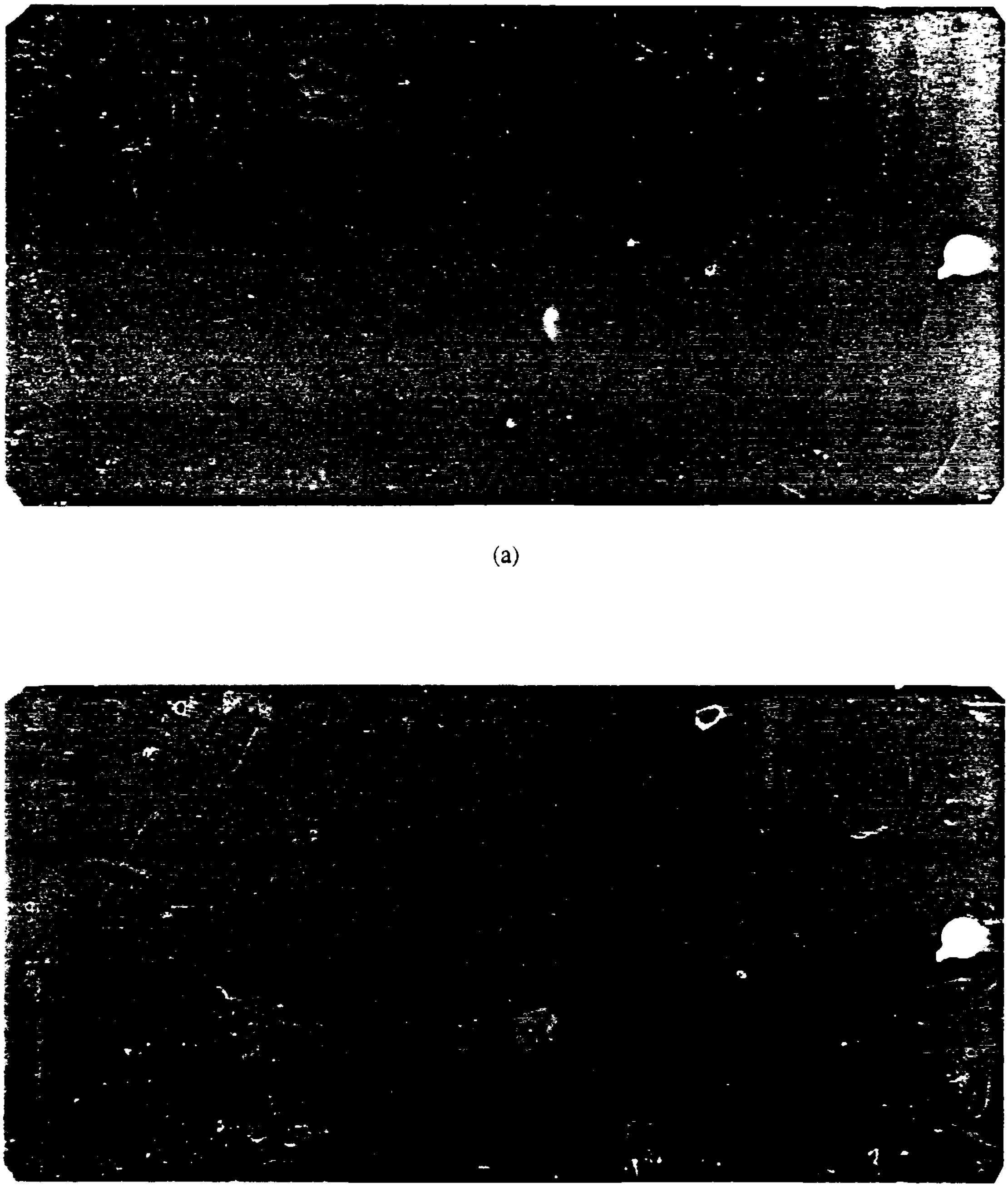


(a)



(b)

Figure 5. Solid film lubricant per General Data Drawing B8769470 (successful).



(a)

(b)

Figure 6. Chemical agent resistant coating (successful).

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